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SURVEY ON MOBILITY OF SINK IN GEOGRAPHIC ROUTING

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ABSTRACT

Over the last few years, an elevation in the use and development of sensor networks was seen. Energy efficient methods have been implemented on the sensor networks for data routing. Static sinks have proved to be uneconomical than mobile sinks. This paper focuses mainly on mobility of sink node in geographic routing of packets in the sensor networks. The effect of mobile sinks on lifetime of the networks and their impact on routing of packets has been analyzed in this paper.

KEYWORDS: SLPS, LLNK, LOOP, Protocol Stack, Mobility

INTRODUCTION

Geographic routing for wireless sensor networks has become a significant field of research over the 0 past few years [1] [2]. In this technique, each node determines its own location typically using the Global Positioning System [10][11] and periodically broadcasts the information about its location to other nodes. Even after the sensor networks have lots of advantages, its limitation cannot be ignored. The energy consumption in sensor networks is a major concern in today's scenario. The static nodes in the network lead to many discrepancies during the routing of the packet information, mainly, due to the location errors caused by the approximations in the coordinates of the location given by the GPS [7] [8]. Geographic routing can be implemented using the progressive approach[5] [6], namely the estimated distance on the line joining the source and destination (MFR, NFP [4]), or the minimal angle that the neighbor makes with the destination node as in Compass Routing [3]. The mobility of the sink node is a vital concept nowadays. In this, network lifetime is increased by the sink mobility using two methods: mobility time-scale and delay time-scale. Mobility time-scale is the time over which the significant portion of the network is covered by the movement of mobile sink .Delay time-scale is the tolerable delay that can incur between the origin and the sink.

Fast Mobility: In this, mobile time-scale is nearly the same as the delay time-scale. Mobility capacity is the ability of transporting information physically in mobile nodes rather transmitting it through wireless links. In mobile relay approach, the data is picked up from the nodes and transported back with the mechanical movement by the mobile sink. Data is picked up when sink moves as close to a node as possible before asking the node to transmit its data [18, 22].

Slow Mobility: In this, mobile time-scale is longer than delay time –scale. In this case, there is no benefit from mobility capacity to the network because the delay bounds of most of the packets would be exceeded. In this case, there is no benefit from mobility capacity to the network because the delay bounds of most of the packets would be exceeded [18].

When the sink is mobile it can reduce the efforts and traffic of the node that is the last hop and thereby decreasing the energy dissipation of that node [18]. This paper is basically analyzing the impact of mobility on the sensor networks, the parameters that are getting affected and their effect on the network performance.

SENSOR NETWORKS COMMUNICATION ARCHITECTURE

The sensor field that has within it the sensor nodes are scattered as shown in Fig. 1. Each of the *scattered* sensor nodes has the ability to route the data after data collection is complete. Multihop infrastructure less architecture is used to route the data back to the sin as shown in Figure 1. The sink may communicate with the user node via The Internetwork.

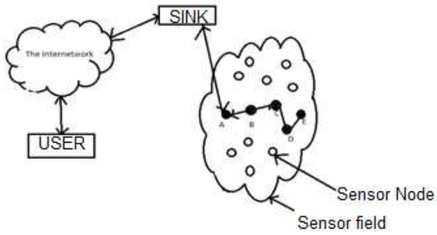

Figure 1

Design Constraints

- Fault Tolerance
- Scalability
- Production Costs
- Hardware Constraints
- Software Constraints
- Transmission Media
- Environment
- Power Consumption[1][17]

The Stack of Protocols

Study and survey of the various layers and different management planes with respect to sensor nodes was done. This protocol stack combines power and routing awareness, integrates data with networking protocols, communicates power efficiently through the wireless medium, and promotes cooperative efforts of sensor nodes. The protocol stack consists of the physical layer, data link layer, network layer, transport layer, application layer, power management plane, mobility management plane, and task management plane[17].

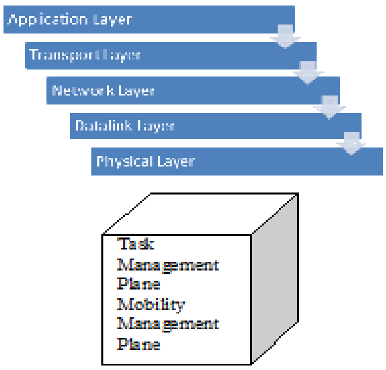

Figure 2: Protocol Stack

Simple Location Propagation Scheme (SLPS)

- An important feature of wireless communication is that a node can overhear transmitting packets [20] [1] in the neighborhood even though the packets are not destined for it; which is exploited in SLPS.
- The motivation of SLPS is that, with the overhearing feature of wireless transmission, if the link in between is bidirectional, then the transmissions from one node can be overheard by the other one [20].

PRESENCE OF LOCATION ERRORS IN MOBILE SINK

There are several location errors that exist due to the errors in location that is given by the GPS [10] [11]. The errors in mobile nodes that can occur are:

- Lost link problem(LLNK)
- LOOP problem

LLNK

Greedy forwarding which is used in GPSR is based on the principle of forwarding a packet to the one which is closest to the destination node amongst the list of neighbors of the source node. The source node starts searching its list in order to find out a node that is closest to the destination and as a result of this forwards the required packet to the selected neighbor. However, the selected node may not be present in the radio range of the source node while it is still listed as its neighbor. This situation is known as *lost link (LLNK)* problem [21].

LOOP Problem

With GPSR, packet is destined for the coordinate of the destination mentioned in the packet header and node is identified only when the packet is reached at the destination node in greedy forwarding. Let us take a situation in which when a destination node is moved away from its original location and another node becomes closest to the original coordinate mentioned in the header of the destination.

This situation is considered as local maximum by GPSR. However, packets generally get dropped till the time the destination node comes back to its original location and is the closest node to the destination packet. This situation is known as LOOP problem [21].

METRICS TO ANALYZE THE MOBILITY IN GEOGRAPHIC ALGORITHM

The impact on the performance of the protocol can be analyzed both quantitatively and qualitatively using several protocol dependent and protocol independent performance metrics. The metrics we use can be identified as:

- Protocol Independent Metrics.
- Protocol performance metrics

Protocol Independent Metric

These metrics are used to differentiate the mobility pattern in geographical algorithm. The differentiation is based upon the characteristics of spatial dependency, temporal dependency and geographic restrictions imposed on the algorithm.

- **Temporal Dependency:** Due to physical constraints of the mobile entity itself, the velocity of mobile node will change continuously and gently instead of abruptly, i.e. the current velocity is dependent on the previous velocity.[21]
- **Spatial Dependency:** The movement pattern of a mobile node may be influenced by and correlated with nodes in its neighbourhood. [21]
- **Geographic Restrictions:** In many cases, the movement of a mobile node may be restricted along the street or a freeway. A geographic map may define these boundaries. [21] Refer Table 1 for comparison.

Protocol Performance Metrics

Some basic terminologies can be used to analyse the mobility in geographic routing which are:

- **Vi (t):** Velocity vector of node i at time t
- **|Vi (t)|:** Speed of node i at time t.
- **θ (t):** Angle made by _Vi(t) at time t with the X-axis
- **xi (t):** X co-ordinate of node i at time t
- **yi (t):** Y co-ordinate of node i at time t.[21]

ROUTING DATA TOWARDS A MOBILE SINK

A routing protocol that transfers data towards a sink should perform the following operations that are not needed for traditional WSNs:

- Notify a node when its link with the sink gets broken due to mobility.
- Inform the whole network of the topological changes incurred by mobility.
- Minimize the packet loss during the sink moving period.

Mobi-Route- is a routing protocol that was designed specifically for data transmission of WSNs. Here the focus is on minimizing Emax, which is the maximum energy dissipation of any single node in the network (refer Table 1 for comparison)

Distributed distance-vector based approach is used in this: exchange of route messages (i.e., control packets) takes place periodically amongst neighbor nodes, and the routing costs of the next hop nodes (or parents in MobiRoute architecture) are evaluated by different neighbors. The route messages that are exchanged help in evaluating the link qualities (from both directions) between nodes apart from measuring the distance (in terms of the number of possible transmissions) from the sink [18].

As a result, a Minimum Transmission (MT) metric is applied in MobiRoute, where minimizing the total number of transmissions is the prime objective. Route messages need not be exchanged frequently since WSNs acquire a low data rate in is low. Thereby MobiRoute reduces its energy consumption greatly [18].

States in MobiRoute**-** MobiRoute applies a beacon mechanism so as to inform state of the neighboring nodes to the sink trace .The sink, periodically broadcasts a beacon message. A detecting timer is set/reset, upon receiving a beacon

message. The node indicates a link breakage and a new parent is chosen if before receiving the next beacon message, the time out of the timer is reached [18].

In relevance to Figure 2, first, a sink is required to transit from the sojourn state to the pre-move state before physically beginning to move. The sink begins to broadcast beacon message under the pre-move state and evolves to the move state after a while. The sink moves while broadcasting beacon message under the move state. A node, after receiving the first beacon message under its current sojourn state, transits to the move state directly. The importance of the pre-move state can be straightforwardly seen: it guarantees the reception of beacon message at the nodes' side before the link quality changes due to the sink mobility.

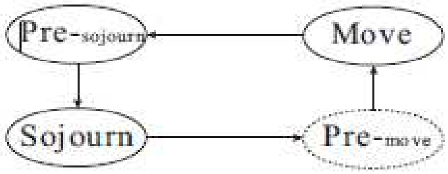

Figure 3: States of a Mobile Node

COMPARISION BETWEEN STATIC AND MOBILE SINK

The following table compares the static and mobile sink based on various parameters discussed in the above sections. Refer table 1 for the comparisons.

Table 1: Comparison between Static and Mobile Sink

Parameters	Static Sink	Mobile Sink
Emax	higher	Lower
Duty Cycle	For duty cycle>=20%, static sink has higher Emax	For duty cycle<20%, Emax in mobile sink depends on mobile radius
Lifetime	lesser	More and even better in case of multiple mobile nodes
Reliability	lesser	higher
Temporal Dependency	Not applicable in case of static nodes	When both nodes travel in the same direction and same speed. When the relative direction or speed ratio of both nodes decreases.
Spatial Dependency	Not applicable in case of static nodes	When both nodes travel in the same direction and same speed. When the relative direction or speed ratio of both nodes decreases.

CONCLUSIONS

The sensor network lifetime and other parameters can be improved by using the concept of mobility of sink. The errors that occur due to location of mobile sink has also been analyzed. The analysis of the mobility of the can be done using the above mentioned metrics. The concept of mobile sink is advantageous for the performance of the system.

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